Embedded Solutions

PU2/PU3/PU4 – 3U 8HP Power Supply Units for 19" Systems

24, 36-48 or 72-110 VDC nom.

User Manual

mikro elektronik
gmbh · nürnberg

PU2/PU3/PU4 – 3U 8HP PSUs for 19" systems, 24, 36-48 and 72-110 VDC nom.

The 3U 8HP power supply unit is a plug-in device for 19" systems (e.g. VMEbus, CompactPCI®) and is especially designed for railway computer systems, being fully compliant with EN 50155.

The PSU comes in three versions with nominal input voltages of 24 (PU2), 36 to 48 (PU3) and 72 to 110 VDC (PU4) with a wide input range of 0.7 to 1.25 times the nominal voltage and a max. input voltage range of 0.6 to 1.4 times the nominal voltage (according to EN 50155).

It is controlled by a microprocessor which supervises the output voltage and the temperature, as well as three external inputs and three outputs.

Thanks to the on-board intelligence the PSU can also act as an SMBus slave and communicate with the CPU board via the backplane. This allows the PSU to power-on the system at a programmed date or it allows the CPU to make status polls with regard to error messages, time-out, on/off, for example.

The PSU provides a DC/DC converter to generate the isolated 5 V from the input voltage. A buck regulator generates 3.3 V from the 5 V isolated side. The maximum power at full load is 35 W.

The subassembly is conformally coated, and components are secured against vibration. The PSU operates in -40 to +85°C environmental temperature. The thermal stress is extremely low due to integrated heat sinks and diversion of dissipated heat over the mounting surface.

Technical Data

Microcontroller

- Output voltage and temperature supervision (readable via SMBus)
- Overtemperature and overvoltage (output) shutdown
- Communication with CPU
- Watchdog functionality

SMBus

- Signals on back connector
- Voltage level 3.3 V
- Controlled by CPU
- Communication between the power supply unit and the CPU

Binary I/O

- 3 binary inputs
  - Voltage level according to external power supply input voltage (max. 154 VDC)
  - Electrically isolated
  - External switch (key) with binary input
  - Switch-on by key input or wake-on time
  - Switch-off by key input or software
  - Status of binary inputs readable via SMBus
  - User-specific functionality (depending on firmware)
- 3 binary outputs
  - Max. voltage 154 V
  - Isolated by relays
  - User-specific functionality (controllable via SMBus)
  - Maximum switching power: 60 W

Miscellaneous

- DC/DC Converter
  - Fuse-protected
- Two status LEDs on front panel
  - Green LED indicates correct input voltage
  - Yellow LED indicates correct output voltage
- Alternative power supply at the backplane for use as redundant PSU
- Short circuit protection
- Reverse polarity protection by internal protector
- Fixed switching frequency: 250 KHz

Input Characteristics

- Nominal voltage input: 24 VDC (PU2), 36-48 VDC (PU3), 72-110 VDC (PU4)

- Wide input range: 0.7 x nominal voltage < nominal voltage < 1.25 x nominal voltage (according to EN 50155)
  - 16.8..30 VDC (PU2)
  - 25.2..60 VDC (PU3)
  - 50.4..137.5 VDC (PU4)
- Max. input voltage range: 0.6 x nominal voltage < nominal voltage < 1.4 x nominal voltage with full functionality for 0.1 s, no damage for 1 s (according to EN 50155)
  - 14.4..33.6 VDC (PU2)
  - 21.6..67.2 VDC (PU3)
  - 43.2..154 VDC (PU4)
- No load input power: 900 mW

Output Characteristics

- Output power (max.): 35 W
- 5V tolerance: +5%/-3%
- 3.3V tolerance: ±3%
- Overvoltage protection: +0.5 V/-0.2 V
- Overtemperature shutdown: 50..90°C (adjustable by SMBus command)

Connection

- Input and output via DIN 41612 plug connector, type H15

Electrical Specifications

- Isolation (according to EN 50155)
  - Input/output: 1,500 VDC/1,000 V_{RMS}
  - Input/shield: 1,500 VDC/1,000 V_{RMS}
  - Output/shield: 1,500 VDC/1,000 V_{RMS}
  - Ground/shield: 1,500 VDC/1,000 V_{RMS}
- MTBF: 240,600 h @ 40°C (derived from MIL-HDBK-217F)

Mechanical Specifications

- Dimensions: 3U, 8HP, 128.4 mm height
- Integrated heat sink
- Weight: 665 g

Environmental Specifications

- Temperature range (operation): -40..+85°C
- Temperature range (storage): -40..+85°C
- Airflow min. 10 m³/h
- Shock: according to EN 60068-2-27
- Continuous shock: according to EN 60068-2-29
- Vibration: according to EN 60068-2-6
- Protection
  - Class of protection: Class II, EN 60950
  - Degree of protection: IP20 (insert in rack), EN 60529

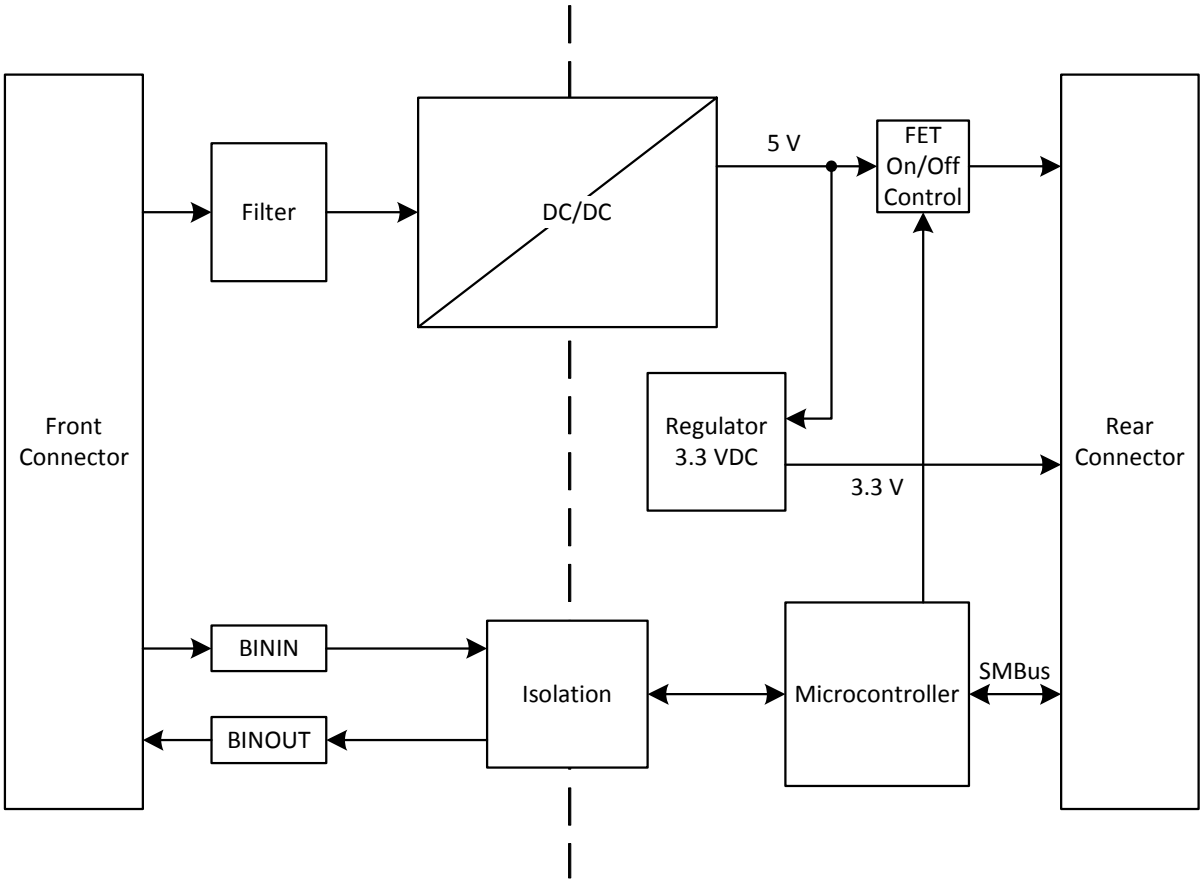
EMC

- Tested according to EN 55022 (radio disturbance), EN 61000-4-2 (ESD), EN 61000-4-4 (burst) and EN 61000-4-5 (surge)

Software Support

- Driver software for Windows®; Linux, VxWorks (on request)
- For more information on supported operating system versions and drivers see online data sheet.

Block Diagram



Product Safety

Electrostatic Discharge (ESD)

Computer boards and components contain electrostatic sensitive devices. Electrostatic discharge (ESD) can damage components. To protect the board and other components against damage from static electricity, you should follow some precautions whenever you work on your computer.

- Power down and unplug your computer system when working on the inside.
- Hold components by the edges and try not to touch the IC chips, leads, or circuitry.
- Use a grounded wrist strap before handling computer components.
- Place components on a grounded antistatic pad or on the bag that came with the component whenever the components are separated from the system.
- Store the board only in its original ESD-protected packaging. Retain the original packaging in case you need to return the board to MEN for repair.

About this Document

This user manual describes the hardware functions of the board, connection of peripheral devices and integration into a system. It also provides additional information for special applications and configurations of the board.

The manual does not include detailed information on individual components (data sheets etc.). A list of literature is given in the appendix.

History

Issue	Comments	Date
E1	First issue	2006-11-15
E2	Update, error correction	2007-05-14
E3	Corrected and added more detailed information regarding input voltage range Cosmetics	2010-06-23
E4	Modified technical data to reflect extended voltage range of PU3 (also suitable for 48 VDC nom.) and PU4 (also suitable for 72 VDC nom.) Previous minimum power limit no longer applies Clarified pin assignment regarding binary outputs, marked one set of power outputs as alternate Added connection example figure Added figure to binary output sub-chapter Added information regarding use in a redundant system with multiple PUx models connected in parallel Other minor changes, cosmetics	2011-09-12

Conventions

This sign marks important notes or warnings concerning proper functionality of the product described in this document. You should read them in any case.

italics Folder, file and function names are printed in *italics*.

bold **Bold** type is used for emphasis.

`monospace` A `monospaced` font type is used for hexadecimal numbers, listings, C function descriptions or wherever appropriate. Hexadecimal numbers are preceded by "0x".

comment Comments embedded into coding examples are shown in green color.

hyperlink Hyperlinks are printed in blue color.

The globe will show you where hyperlinks lead directly to the Internet, so you can look for the latest information online.

IRQ#
/IRQ

Signal names followed by "#" or preceded by a slash ("/") indicate that this signal is either active low or that it becomes active at a falling edge.

in/out

Signal directions in signal mnemonics tables generally refer to the corresponding board or component, "in" meaning "to the board or component", "out" meaning "coming from it".

Vertical lines on the outer margin signal technical changes to the previous issue of the document.

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Please recycle

Germany
MEN Mikro Elektronik GmbH
Neuwieder Straße 5-7
90411 Nuremberg
Phone +49-911-99 33 5-0
Fax +49-911-99 33 5-901
E-mail info@men.de
www.men.de

France
MEN Mikro Elektronik SA
18, rue René Cassin
ZA de la Châtelaine
74240 Gaillard
Phone +33 (0) 450-955-312
Fax +33 (0) 450-955-211
E-mail info@men-france.fr
www.men-france.fr

USA
MEN Micro, Inc.
24 North Main Street
Ambler, PA 19002
Phone (215) 542-9575
Fax (215) 542-9577
E-mail sales@menmicro.com
www.menmicro.com

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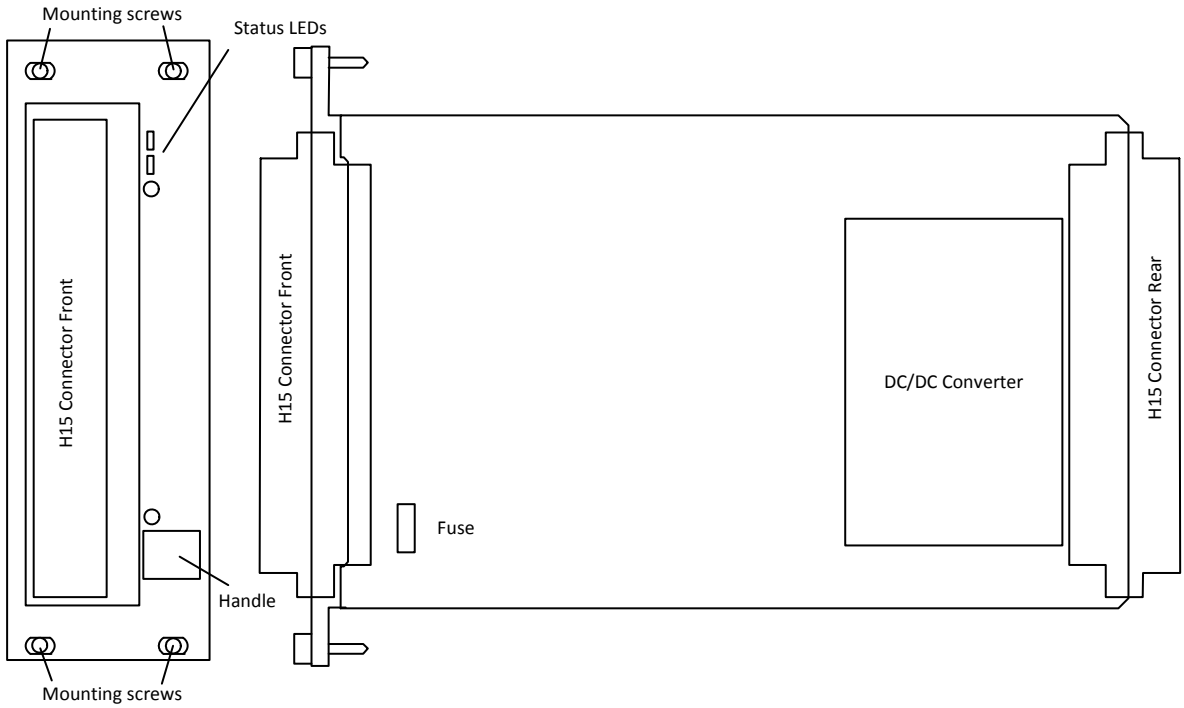
1 Getting Started

This chapter gives an overview of the board and some hints for first installation in a system.

1.1 Map of the Board

Figure 1. *Map of the board – front panel and top view*



1.2 Integrating the Board into a System

This chapter gives important information on first installation of the PSU.

- ☑ Power down the system before installing or removing the PSU.
- ☑ Only operate the PSU in a suitable housing, i.e. in such a way that no parts of the PSU except the front panel can be touched.
- ☑ Make sure that enough airflow is provided.
- ☑ Do not remove any covers or other mechanical parts.
- ☑ The guiderails should be made of synthetic material and not touch any components.

1.3 Installing Driver Software

For a detailed description on how to install driver software please refer to the respective documentation.

You can find any driver software available for download on MEN's website.

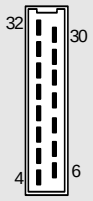
2 Connecting the PSU

The PSU can be connected via two H15 connectors at the front and at the rear side.

Connector types:

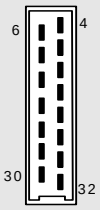
- 15-pin H15 receptacle according to IEC 60603-2
- Mating connector: 15-pin H15 plug according to IEC 60603-2

Table 1. *Pin assignment of H15 PSU connector (front)*



32	GND(I/O)	30	BININ2
28	BININ3	26	BINOUT3 RC2
24	BINOUT3 RC1	22	BINOUT2 RC2
20	BINOUT2 RC1	18	BINOUT1 RC2
16	-	14	BINOUT1 RC1
12	BININ1	10	V_{in}-
8	-	6	V_{in}+
4	SHIELD		

Table 2. *Pin assignment of H15 PSU connector (rear)*



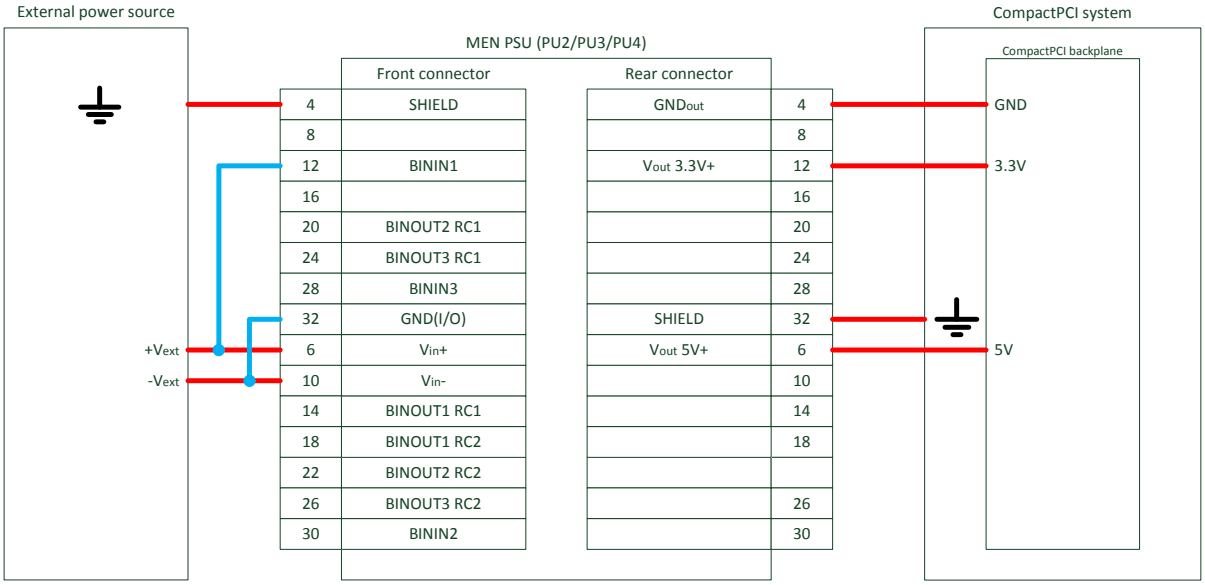
6	Vout5V+	4	GNDout
10	Vout5V+	8	Vout3.3V+
14	5V+ (3.3V Switch)	12	Vout3.3V+
18	SMBClk	16	System Reset
22	GND out	20	SMBDat
26	-	24	-
30	-	28	-
		32	SHIELD

Note: Pin 32 is longer than the other pins.

Table 3. *Signal mnemonics of PSU interfaces*

Signal	Function
SHIELD	Connection to cable shield
Vin+	Supply input voltage
Vin-	Supply input ground
BININ1	Key input
BINOUT1 RC1	User output1 relay contact 1
BINOUT1 RC2	User output1 relay contact 2
BINOUT2 RC1	User output2 relay contact 1
BINOUT2 RC2	User output2 relay contact 2
BINOUT3 RC1	User output3 relay contact 1
BINOUT3 RC2	User output3 relay contact 2
BININ3	Input
BININ2	Input
GND(I/O)	Key input ground
GNDout	Ground for system
Vout5V+	5V supply for system
Vout3.3V+	3.3V supply for system
5V+ (3.3V Switch)	12V for detection only (no power)
System Reset	Pushbutton reset
SMBClk	SMBus clock
SMBDat	SMBus data (handshake between CPU and PSU)

Figure 2. *Connection example*



2.1 Using the PSU in a Redundant Configuration

The PSU can be used in parallel with other PSUs of the same type for increased availability. There are a few limitations to such a configuration, though:

- It does not increase the maximum load.
- A failed PSU will not be able to sense that it has failed.

Both PSUs operate at the same address, so do not use SMBus commands!

3 Functional Description

The functions described in the following chapter depend on the firmware. This user manual describes the functions realized in the current MEN standard firmware.

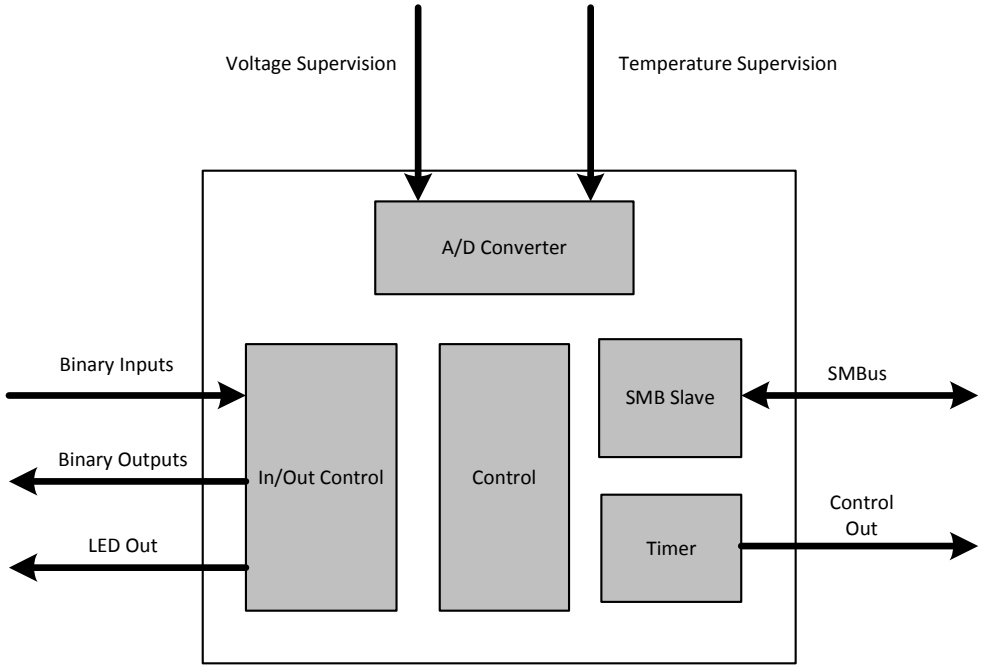
3.1 Microcontroller

The microcontroller is used as a control and supervision device of the DC/DC converter and of the binary inputs and outputs of the PSU. Additionally it is used as a watchdog for the CPU and the microcontroller itself. The microcontroller is connected to the SMBus of the CompactPCI system. It controls the binary outputs and is able to read the binary inputs. It is able to keep the power supply active, even if the external on/off-signal goes inactive.

The microcontroller controls the CompactPCI reset signal to be able to reset the complete CompactPCI bus. If a reset shall be performed the CompactPCI reset signal is asserted for 250 ms.

Note: An operating system like Windows needs a controlled power down sequence. The power supply of the CPU can be kept active via the SMBus even when the external on/off signal of the PSU is inactive so that a controlled power down of the operating system is possible. For further information see Chapter 3.6.7.4 Off Delay on page 28.

Figure 3. *Microcontroller block diagram*

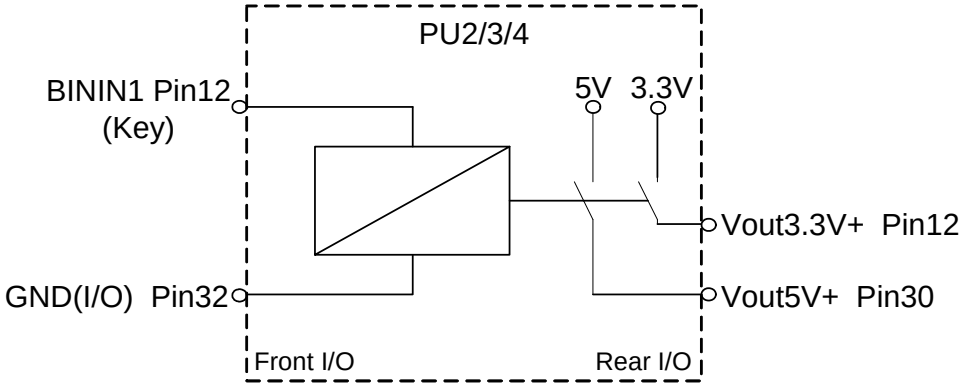


3.2 Power Up

The PSU can be switched on in the following two ways:

- Key input (ignition key) via isolated binary input (see Chapter 3.6.6 Key Input on page 25).

Figure 4. *Power up by key input*



- Wake on time via the SMBus interface (see Chapter 3.6.3 Wake On Time on page 22).

3.3 Power Down

The PSU can be switched off in the following two ways:

- Key input (ignition key) via isolated binary input (see Chapter 3.6.7.2 Shutdown by Key Input on page 26).
- Shutdown by application software: the shutdown can be signaled via an SMBus command from application to host (see Chapter 3.6.7.1 Shutdown by Software on page 26).

3.4 Binary I/O

3.4.1 Binary Inputs

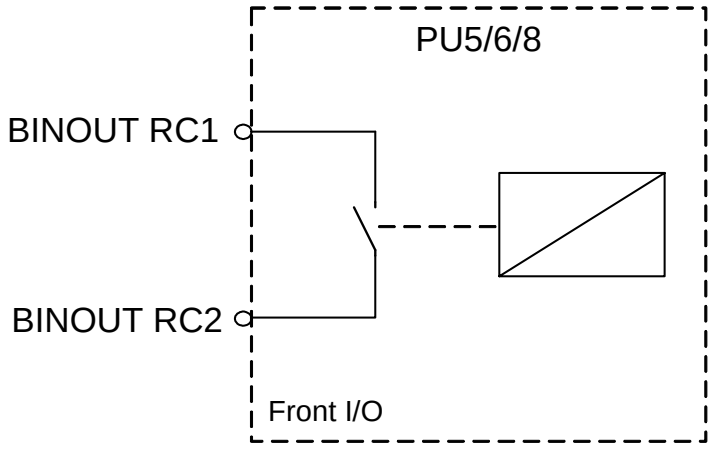
The PSU provides three binary inputs. The binary inputs are isolated from the isolated system ground. The input voltage range is 0 V up to 154 V. The nominal switching level is 9 V. The current is 5 mA. This value is independent of the input voltage.

The isolated binary inputs are led to the microcontroller and can be used for user specific functionality dependent on the firmware. The state of the binary inputs can be read via the SMBus interface. See Chapter 3.6.5 Status of Binary Inputs and Outputs on page 24.

3.4.2 Binary Outputs

The power supply unit provides three binary outputs. They are controlled by the microcontroller and the state of the outputs is controllable via SMBus.

Figure 5. *Binary output relay (one of three binary outputs shown)*



The binary outputs are isolated by relays between each other and isolated system ground. The default setting of "BINOUTx RC1" and "BINOUTx RC2" is open.

The maximum switching power of each binary output is 60 W.

The state of the binary outputs can be read via the SMBus interface. See Chapter 3.6.5 Status of Binary Inputs and Outputs on page 24.

3.5 Status LEDs

The PSU provides two status LEDs at the front panel. The green LED is on when the input voltage is in the correct range, the yellow LED is on when the output voltage is in the correct range. The yellow LED blinks when the PSU is switched to error state off. See Chapter 3.6.4.1 Error Off State on page 23.

Table 4. *Status LEDs on the front panel*

LED	Function
Green LED	On: input voltage in correct range
Yellow LED	On: output voltage in correct range Blinking: error state off

3.6 SMBus

3.6.1 General

The System Management Bus (SMBus) is a two-wire interface through which various system component chips can communicate with each other and with the rest of the system. It is based on the principles of operation of I²C.

SMBus provides a control bus for system and power management related tasks. A system may use SMBus to pass messages to and from devices instead of tripping individual control lines. Removing the individual control lines reduces pin count. Accepting messages ensures future expandability.

With System Management Bus, a device can provide manufacturer information, tell the system what its model/part number is, save its state for a suspend event, report different types of errors, accept control parameters, and return its status.

3.6.2 SMBus Interface

The microcontroller firmware supports SMBus slave device functionality. The SMBus address of the PSU is `0x12`. The microcontroller behaves according to the SMBus Specification Version 2.0 (see Chapter 4.1 Literature and Web Resources on page 34), but it only supports the write-byte and the read-byte protocol without PEC. The supported SMBus commands and their functions are explained in the following chapters. The commands are listed by their unique name. Column "Data Range" lists the valid range of the data byte for the specific command code. Column "Type" specifies the data direction for the specific command. 'r' specifies that the host can read the data using the SMBus read-byte protocol. 'w' means the host can write data using the SMBus write-byte protocol.

3.6.3 Wake On Time

The PSU can be switched on/off by a programmable timer. The timer is included in the microcontroller and is programmable by the CPU via SMBus commands (see Table 5, SMBus commands for wake on time function, on page 22).

The behavior after power up by wake on time is identical to the behavior after power up by key input. After the first wake on time event the wake on time feature is disabled.

Note: For the timer functionality it is necessary that the DC/DC converter and the microcontroller are active.

Table 5. *SMBus commands for wake on time function*

Name	Command Code	Data Range	Type	Description
AD78C_WOT_L	0x00	0x00.. 0xFF	r/w	Wake on time low byte
AD78C_WOT_H	0x01	0x00.. 0xFF	r/w	Wake on time high byte

The wake on time delay can be configured via SMBus in a 16 bit counter to provide the range according to the following table:

Table 6. *SMBus commands AD78C_WOT_L/ AD78C_WOT_H*

Minimum	Maximum	Description
0 (OFF) (default)	65,535 min	*AD78C_WOT_L* and *AD78C_WOT_H* build a 16 bit value which represents the time in minutes

3.6.4 Watchdog

The microcontroller is also used as a watchdog for the CompactPCI system.

It is possible to enable/disable the watchdog by the SMBus command *AD78C_WDOG_STATE*. After the *AD78C_STATUS* byte (see Table 13, SMBus commands for shutdown delay, on page 27) signaled a shutdown the watchdog is disabled by the firmware. The watchdog is triggered by cyclic SMBus commands (*AD78C_WDOG_TRIG*) from the CPU. The time interval between trigger commands is configurable via SMBus command *AD78C_WDOG_TOUT* (see Table 8, SMBus command AD78C_WDOG_TOUT, on page 23). The time interval is set to its maximum value after PSU power up and the watchdog is disabled. In case of missing trigger, the microcontroller firmware resets the complete system. The number of missing SMBus trigger command exceptions is incremented and can be read via the SMBus command *AD78C_WDOG_ERR*.

After five exceptions the microcontroller firmware switches off the power output (V_{out}) and switches to error off state (see Chapter 3.6.4.1 Error Off State on page 23). After a watchdog reset the firmware waits for the SMBus on acknowledge signal before it restarts the watchdog timer. Care must be taken if the SMBus on acknowledge feature is not used and the system is not able to start within the watchdog timeout time. In this case a deadlock situation occurs and after several watchdog exceptions the system will fall into the error off state.

Table 7. *SMBus commands for watchdog function*

Name	Command Code	Data Range	Type	Description
AD78C_ONACK	0x02	0	w	On acknowledge
AD78C_ONACK_TOUT	0x03	0x00.. 0x0B	r/w	On acknowledge timeout
AD78C_ONACK_ERR	0x04	0x00.. 0xFF	r	Number of missing on acknowledges
AD78C_WDOG_STATE	0x05	0x00, 0x01	r/w	Watchdog state
AD78C_WDOG_TRIG	0x06	0	w	Watchdog trigger signal
AD78C_WDOG_TOUT	0x07	0x01.. 0xFF	r/w	Watchdog timeout in 100ms steps
AD78C_WDOG_ERR	0x08	0x00.. 0xFF	r	Number of missing on watchdog trigger signals

Table 8. *SMBus command AD78C_WDOG_TOUT*

Value	Watchdog Timeout
1	100 ms
2	200 ms
3	300 ms
...	
255	25.5 s (default)

3.6.4.1 Error Off State

If five watchdog or SMBus on acknowledge exceptions have occurred the microcontroller firmware switches to an error off state. This state is also reached if an overtemperature or overvoltage condition has occurred. Upon entering this state V_{out} is immediately deactivated. In this state it is not possible to switch on the system in any way. To leave this state the power of the PSU must be disconnected (power on reset of the PSU). This state is signaled via blinking of the yellow LED.

3.6.5 Status of Binary Inputs and Outputs

The status of the binary inputs and outputs is also signaled via SMBus commands. See Table 9, SMBus commands for binary inputs/outputs status, on page 24.

Table 9. *SMBus commands for binary inputs/outputs status*

Name	Command Code	Data Range	Type	Description
AD78C_IN	0x0E	0x00.. 0xFF	r	State of binary inputs
AD78C_IN_MASK	0x0F	0x00.. 0x0F	r	Signal if binary input is usable from application
AD78C_OUT	0x10	0x00.. 0x0F	r/w	State of binary outputs
AD78C_OUT_MASK	0x11	0x00.. 0x0F	r	Signal if binary output is usable from application

3.6.6 Key Input

3.6.6.1 Key Input On

The firmware switches on the output power (V_{out}) whenever the debounced state of the binary input used as key switches from low to high state (on event). The firmware debounces the key input in the following way: if the input is stable for 250ms the input state is interpreted.

3.6.6.2 SMBus On Acknowledge

The firmware provides an SMBus on acknowledge feature. This feature is enabled by using mode 1 to 11 according to Table 11, SMBus on acknowledge timer modi, on page 26. Default mode is 0 (feature disabled, no SMBus acknowledge required). If enabled and the microcontroller does not receive a SMBus on acknowledge during the configurable SMBus on acknowledge delay, the microcontroller firmware resets the complete system by activating the CompactPCI reset output. The number of missing SMBus acknowledge exceptions are incremented and can be read via SMBus command *AD78C_ONACK_ERR.*

After reset is released, the acknowledge timer is restarted and the microcontroller firmware waits for SMBus acknowledge. After five exceptions the microcontroller firmware disables the power output V_{out} (see Chapter 3.6.4.1 Error Off State on page 23). After a power up of the PSU the on acknowledge configuration is reset.

Table 10. *SMBus commands for on acknowledge function*

Name	Command Code	Data Range	Type	Description
AD78C_ONACK	0x02	0	w	On acknowledge
AD78C_ONACK_TOUT	0x03	0x00.. 0x0B	r/w	On acknowledge timeout
AD78C_ONACK_ERR	0x04	0x00.. 0xFF	r	Number of missing on acknowledges

Table 11. *SMBus on acknowledge timer modi*

Mode	SMBus On Acknowledge
0	Feature disabled = no acknowledge required (default)
1	1 s
2	2 s
3	4 s
4	8 s
5	16 s
6	32 s
7	64 s
8	128 s
9	256 s
10	512 s
11	1024 s

3.6.7 Shutdown

3.6.7.1 Shutdown by Software

At any time it is possible to shut down the power supply by software via SMBus command *AD78C_SWOFF*. A shutdown by software follows the shutdown sequence.

Table 12. *SMBus command for shutdown by software function*

Name	Command Code	Data Range	Type	Description
AD78C_SWOFF	0x09	0	w	Signal a software power off from application

3.6.7.2 Shutdown by Key Input

One of the binary inputs can be used as an on/off input. When this signal is passive (open) during power up of the input voltage, the system is not supplied with power. When this signals goes active, the microcontroller switches the power supply to provide the system with power. Nevertheless the DC/DC converter and the microcontroller are supplied when the input voltage is connected.

It is possible at any time to shut down the power supply by switching off the key input. A shutdown by key input follows the shutdown sequence.

3.6.7.3 Shutdown Delay

During the shutdown sequence the microcontroller firmware provides a programmable shutdown delay. The default state of the shutdown delay after power up of the PSU is 0 (disabled). The shutdown delay is configurable via the SMBus command *AD78C_DOWN_DELAY*, see Table 13, SMBus commands for shutdown delay, on page 27 and Table 15, SMBus command AD78C_DOWN_DELAY, on page 27. The shutdown delay timer is started after shutdown event. At any time during the shutdown delay the shutdown sequence can be stopped by an on event (key input on). The system is in running state then and the shutdown delay timer is cleared. After timeout of the shutdown delay the microcontroller firmware signals the shutdown event to the CPU by setting a bit in the status register, which can be read using the SMBus command *AD78C_STATUS* (see Table 13, SMBus commands for shutdown delay, on page 27 and Table 14, SMBus command AD78C_STATUS, on page 27).

Table 13. *SMBus commands for shutdown delay*

Name	Command Code	Data Range	Type	Description
AD78C_DOWN_DELAY	0x0B	0x00.. 0x07	r/w	Shutdown delay
AD78C_STATUS	0x0D	0x00, 0x01	r	Signal PSU status to application

Table 14. *SMBus command AD78C_STATUS*

Bit	Value	Description
0	0	Shutdown event not signaled
	1	Signal shutdown event
1..7	0	Reserved

Table 15. *SMBus command AD78C_DOWN_DELAY*

Value	Shutdown Delay
0	0 min
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min
6	32 min
7	64 min

3.6.7.4 Off Delay

During the shutdown sequence the microcontroller firmware provides a programmable off delay. As default this feature is not enabled (mode 0). In this case there will be no off delay, the supply will be switched off immediately. When enabled (mode 1…5) the firmware starts the off delay timer after signaling the shutdown event to the CPU. After timeout the microcontroller firmware switches off the supply voltage (V_{out}). V_{out} is kept disabled for at least 1 s, even if an immediate on event occurs. This guarantees a proper power on reset of the supplied system. The off delay can be programmed using the SMBus command *AD78C_OFF_DELAY*, for details see Table 16, SMBus command for off delay function, on page 28 and Table 17, SMBus command AD78C_OFF_DELAY, on page 28.

Table 16. *SMBus command for off delay function*

Name	Command Code	Data Range	Type	Description
AD78C_OFF_DELAY	0x0C	0x00.. 0x05	r/w	Off delay

Table 17. *SMBus command AD78C_OFF_DELAY*

Mode value	Off Delay
0	Feature off (no OFF delay: default)
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min

3.6.7.5 Off Acknowledge

The microcontroller firmware enables acknowledging the shutdown. It is possible at any time during off delay to shut down the power supply by the SMBus command *AD78C_OFFACK*.

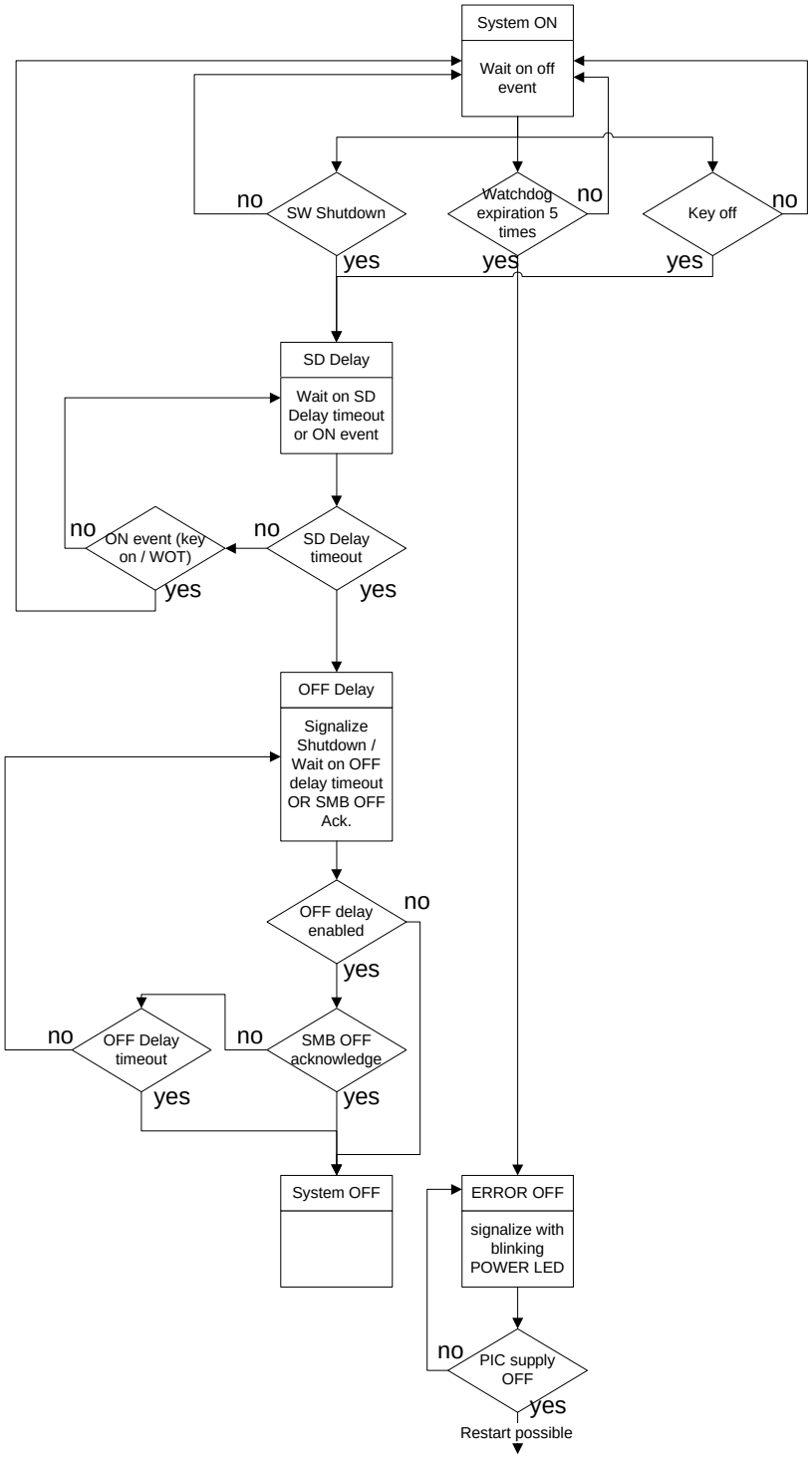
Table 18. *SMBus command for off acknowledge function*

Name	Command Code	Data Range	Type	Description
AD78C_OFFACK	0x0A	0	w	Signal off acknowledge

3.6.7.6 Shutdown Sequence

Any shutdown by software or key input is carried out according to the following sequence:

Figure 6. *Shutdown sequence*



3.6.8 Voltage Supervision

Input and output voltage are supervised by the microcontroller. The status of the input and output is shown by two LEDs at the front panel (see Chapter 3.5 Status LEDs on page 21).

The microcontroller firmware supervises the 5 V output voltage of the DC/DC converter. When the voltage is over 5.5 V, the microcontroller switches off the output power and enters error off state. When the voltage is below 4.8 V, the firmware of the microcontroller resets the system for the time of undervoltage. The output voltage is measured using the microcontroller internal ADC function. The ADC value which represents the output voltage can be read via the SMBus command *AD78C_VOLT* (see Table 19, SMBus command for voltage supervision function, on page 30. The voltage values are specified through their corresponding ADC value. The read ADC values correspond to the voltage value according to the following formula:

$$U = \frac{6 \cdot ADCValue}{255} V$$

In order to provide stable voltage reference a 3 V precision shunt regulator is used. The input voltage will be detected by two comparators.

Table 19. *SMBus command for voltage supervision function*

Name	Command Code	Data Range	Type	Description
AD78C_VOLT	0x14	0x00.. 0xFF	r	5V supply voltage

3.6.9 Temperature Supervision

The microcontroller is able to determine the PSU temperature. The temperature can be read via the SMBus command *AD78C_TEMP* and sent to the CPU.

The temperature supervision is carried out by the temperature sensor LM62. The LM62 is a precision integrated-circuit temperature sensor that can sense a 0°C to +90°C temperature range while operating from a single +3.0 V supply.

The microcontroller reads the output voltage of the LM62 with A/D input.

When the temperature is over the *AD78C_TEMP_HIGH* level the microcontroller switches off the output power and changes to the error off state.

Table 20. *SMBus commands for temperature supervision*

Name	Command Code	Data Range	Type	Description
AD78C_TEMP	0x12	0x00.. 0xFF	r	Current PSU temperature
AD78C_TEMP_HIGH	0x13	0x00.. 0xFF	r/w	Temperature alarm limit (shut down/ switching to error off state)

The level *AD78C_TEMP_HIGH* can be configured via the SMBus between 50°C and 90°C, see Table 21, SMBus command AD78C_TEMP_HIGH, on page 31 and Table 22, Temperature representation, on page 31.

Table 21. *SMBus command AD78C_TEMP_HIGH*

Minimum	Maximum	Description
0x6B (50°C)	0xA0 (90°C) (default)	Temperature alarm level

The temperature limit can be read via the SMBus. The temperature value is specified by the corresponding ADC value according to the following formula:

$$t = \frac{\frac{3 \cdot ADCvalue}{255} - 0.48}{0.0156}\,°C$$

The following table shows how the ADC values correspond to the temperature in °C.

Table 22. *Temperature representation*

ADC Value	Temperature/°C
0x28	0
0x2A	1
0x2B	2
...	...
0xA0	90

3.6.10 PSU ID and Firmware Revision Number

The ID of the PSU and the firmware revision number can also be read via SMBus commands. See Table 23, SMBus commands for PSU ID and firmware revision number, on page 32.

Table 23. *SMBus commands for PSU ID and firmware revision number*

Name	Command Code	Data Range	Type	Description
AD78C_ID	0xFE	0x78	r	ID of PSU
AD78C_REV	0xFF	0x00.. 0xFF	r	Firmware revision of PSU

3.7 DC/DC Converter

The power supply unit provides a DC/DC converter to generate isolated 5 V (+5% ; -3%) with 7 A from the input voltage. An additional buck regulator generates 3.3 V (± 3%) from the 5 V isolated side. The maximum power with full load is 35 W.

Note: The DC/DC converter is on while the input voltage is connected. See Table 24, Maximum no load input power of DC/DC converter, on page 32 for maximum (no load) input power. The maximum output current of 3.3 V is 5 A. For output voltage tolerance the minimum power must be 5 W.

Table 24. *Maximum no load input power of DC/DC converter*

Nominal Input Voltage	24VDC	36-48VDC	72-110VDC
No load input power DC/DC	300 mW	500 mW	800 mW
Other parts	100 mW	100 mW	100 mW
Result power input	400 mW	600 mW	900 mW

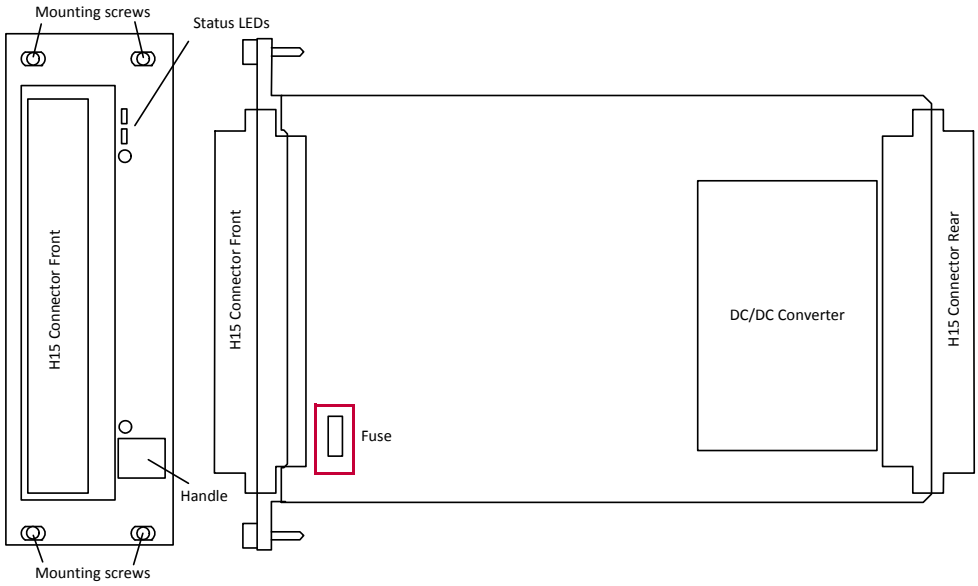
3.7.1 Fuse Protection

The DC/DC converter is protected by a fuse. **This fuse is not intended to be exchanged by the customer. Your warranty for the PSU will cease if you exchange the fuses on your own.** Please send your board to MEN for repair if a fuse blows.

- Current rating:
  - 5A for PU2
  - 2.5A for PU3
  - 1A for PU4
- Type: slow
- Size: 4.5 x 12.1
- MEN part number: 5675-0006 (1A), 5675-0010 (2.5A), 5675-0009 (5A)

The fuse is located on the top side of the PSU.

Figure 7. *Position of fuse for DC/DC converter protection*



4 Appendix

4.1 Literature and Web Resources

- PU2 data sheet with up-to-date information and documentation:
  www.men.de/products/17PU02-.html
- PU3 data sheet with up-to-date information and documentation:
  www.men.de/products/17PU03-.html
- PU4 data sheet with up-to-date information and documentation:
  www.men.de/products/17PU04-.html
- System Management Bus (SMBus) Specification Version 2.0
  August 3, 2000
  SBS Implementers Forum
  www.smbus.org

4.2 Finding out the Product's Article Number, Revision and Serial Number

MEN user documentation may describe several different models and/or design revisions of the PSU. You can find information on the article number, the design revision and the serial number on a label attached to the board.

- **Article number:** Gives the product's family and model. This is also MEN's ordering number. To be complete it must have 9 characters.
- **Revision number:** Gives the design revision of the product.
- **Serial number:** Unique identification assigned during production.

If you need support, you should communicate these numbers to MEN.

Figure 8. *Labels giving the product's article number, revision and serial number*